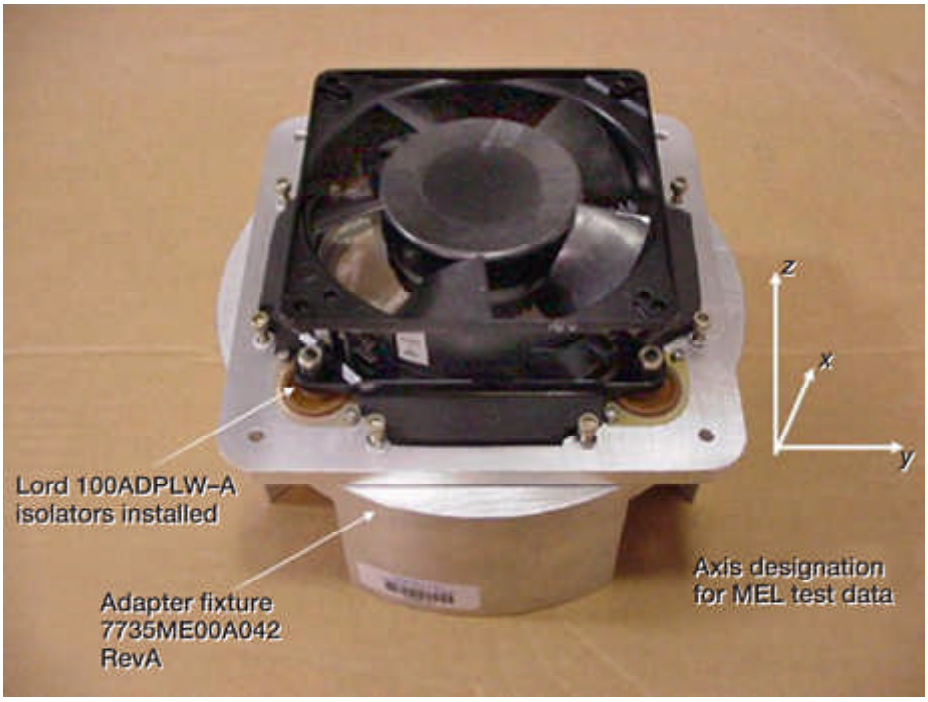
Light Microscopy Module Fan Disturbance Characterized Through Microgravity Emissions Laboratory Testing

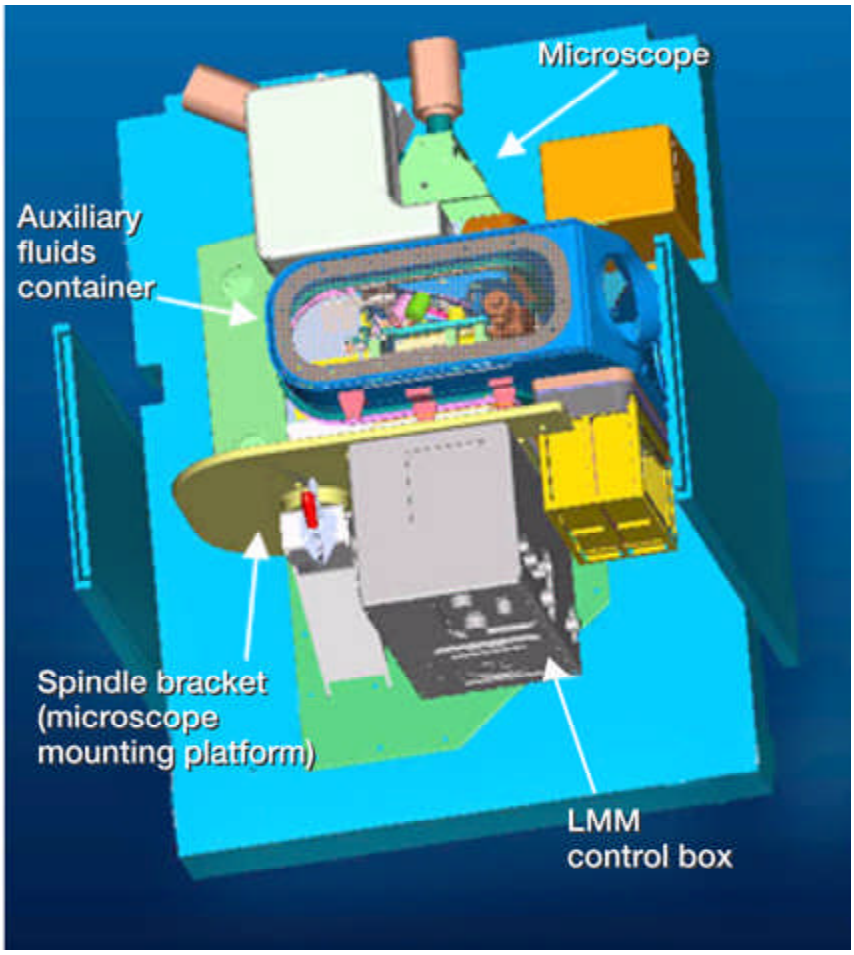
A Light Microscopy Module (LMM) is being engineered, designed, and developed at the NASA Glenn Research Center. The LMM is planned as a remotely controllable on-orbit microscope subrack facility, allowing flexible scheduling and control of physical science and biological science experiments within Glenn's Fluids Integrated Rack on the International Space Station. The LMM concept is a modified commercial research imaging light microscope with powerful laser-diagnostic hardware and interfaces, creating a one-of-a-kind, state-of-the-art microscopic research facility. The microscope will house several different objectives, corresponding to magnifications of ×10, ×40, ×50, ×63, and ×100. Features of the LMM include high-resolution color video microscopy, brightfield, darkfield, phase contrast, differential interference contrast, spectrophotometry, and confocal microscopy combined in a single configuration. Also, laser tweezers are integrated with the diagnostics as a sample manipulation technique. As part of the development phase of the LMM, it was necessary to quantify the microgravity disturbances generated by the control box fan. Isolating the fan was deemed necessary to reduce the fan speed harmonic amplitudes and to eliminate any broadband disturbances across the 60- to 70-Hz and 160- to 170-Hz frequency ranges.



Light Microscopy Module control box fan.

The accelerations generated by a control box fan component of the LMM were measured in the Microgravity Emissions Laboratory (MEL). The MEL is a low-frequency measurement system developed to simulate and verify the on-orbit International Space Station (ISS) microgravity environment. The accelerations generated by various operating components of the ISS, if too large, could hinder the science performed onboard by disturbing the microgravity environment. The MEL facility gives customers a test-verified way of measuring their compliance with ISS limitations on vibratory disturbance levels. The facility is unique in that inertial forces in 6 degrees of freedom can be characterized simultaneously for an operating test article. Vibratory disturbance levels are measured for engineering or flight-level hardware following development from component to subassembly through the rack-level configuration. The MEL can measure accelerations as small as 10-7g, the accuracy needed to confirm compliance with ISS requirements.

Prior to MEL testing, LMM personnel reviewed the LMM assembly finite element analysis models to locate the natural frequencies in structural areas surrounding the location where the sample cells will reside. First natural frequencies of the X-Y stage and the microscope of the LMM were noted to be in the 60- to 70-Hz and 160- to 170-Hz ranges. The control box fan isolation would need to reduce any fan speed harmonics and broadband disturbances in these frequency ranges to maintain the functionality of the LMM.



Light Microscopy Module.

As the inertial forces for the operating control box fan were characterized through MEL testing, results showed that the isolator initially selected did not reduce fan speed harmonics and broadband disturbances in the 60- to 70-Hz frequency range. MEL test personnel concluded that softer isolation would be needed. Trial tests of five Lord Corporation (Mechanical Products Division, Erie, PA) isolators with varying stiffness were completed. MEL test results indicated that the broadband disturbances and fan speed harmonic amplitudes were reduced for force and moment data sets in all 6 degrees of freedom when an isolator with a stiffness of 3 lb/in. was used. On the basis of the MEL results, LMM personnel implemented a design change for the control box fan. In conclusion, the MEL was used not only to characterize MEL inertial forces to assess compliance with ISS requirements for LMM but also to optimize the isolator selection and improve the design of the control box fan interface.

Find out more about this research:

LMM
http://www.cleveland.feddata.com/lmm/
http://microgravity.grc.nasa.gov/6712/lmm.html

MEL
http://www.grc.nasa.gov/WWW/MEL/ http

Glenn's Structural Systems Dynamics Branch:
http://www.grc.nasa.gov/WWW/SSDB/ http

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